mobile station to the other, but via one or more base stations depending on the location of the mobile stations. If there is no link from the mobile stations to a base station, no link can be set up to another mobile station. Such a situation is shown in Figure 4. Although, as shown in Figure 4, the mobile station A can set up a link to the base station, the mobile station B cannot, since it is out of range of the base station (for example, in a valley or on a bridge). No link, therefore, can be set up between the mobile stations A and B even if, for example, there is a visual link between them. Since it has so far not been possible to overcome this disadvantage with mobile radio systems operating in the duplex mode, additional systems such as TETRA (Trans European Trunked Radio Access) have been developed and constructed, in which communication takes place directly between two mobile radios without using a base station. However, a mobile radio system operating in the duplex mode is advantageous for effective use of the available frequencies and base stations.

An object of the present invention is, thus, to provide a mobile radio system and a mobile station which, in addition to transmission/reception operation in the duplex mode, are also suitable for transmission/reception operation in the non-duplex mode.

SUMMARY OF THE INVENTION

Accordingly, a mobile radio system having a number of mobile stations is provided, in which the mobile stations carry out transmission/reception operation in the duplex mode and in the semiduplex mode. The mobile stations are, thus, suitable for setting up communication to one or more mobile stations using the duplex and/or semiduplex mode.

According to one embodiment of the present invention, a first mobile station carries out transmission/reception operation with a base station in the duplex mode, and with a second mobile station in the semiduplex mode. This allows simultaneous communication to be set up from the first mobile station in the duplex mode to the base station and to a second mobile station in the semiduplex mode, even when there is no link from the second mobile station to the base station.

Furthermore, transmission/reception operation can be carried out with the base station in the duplex mode and with the second mobile station in the semiduplex mode, such that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another. The timeslots for the duplex and semiduplex mode, thus can be superimposed (interleaved) in

such a manner that the transmission/ reception operation is carried out virtually simultaneously in the duplex and semiduplex mode without any mutual influence.

If the first mobile station carries out transmission/ reception operation with the base station in the duplex mode and with the second mobile station in the semiduplex mode, such that signals from the base station are transmitted via the first mobile station to the second mobile station and vice versa, communication can be set up between the base station and the second mobile station with the interposition of the first mobile station as a repeater. This can be done even when there is no direct link from the second mobile station to the base station.

In accordance with another embodiment of the present invention, the first mobile station carries out transmission/reception operation with the second mobile station and with a third mobile station in the semiduplex mode. This allows simultaneous communication to be set up directly from the first mobile station to the second and third mobile station in the semiduplex mode without any link to a base station.

If the first mobile station carries out transmission/ reception operation with the second and the third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the one mobile station to the third mobile station and vice versa, communication can be set up between the second and third mobile station with the interposition of the one mobile station as a repeater even when there is no link between the second and third mobile station and any base station.

If a number of mobile stations are coupled to one another, then a communication chain or communication network of any desired size can be produced, in which case communication can be set up via a number of mobile stations with or without using base stations.

In order to avoid loading the power supply device of the first mobile station in an uncontrolled manner, the first mobile station manually or automatically switches on and off the transmission of signals from the second mobile station via the first mobile station to the base station or to the third mobile station, and vice versa. The function of the first mobile station as a repeater, thus, can be activated or deactivated.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Preferred Embodiments and the Drawings.

DESCRIPTION OF THE DRAWINGS

Figures 1 to 3 show various embodiments and operating modes of a mobile radio system according to the present invention;

Figure 4 shows a mobile radio system according to the prior art;

Figure 5 shows an illustration of frequency bands used in connection with the present invention; and

Figure 6 shows an illustration of timeslots used in connection with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Conventional mobile radio systems, such as the GSM system, operate in the duplex mode and generally use a timeslot method in which the transmitter and receiver are active at different times. The transmitter in this case operates in the uplink frequency band, while the receiver operates in the downlink frequency band.

In the present invention, a semiduplex band is required as an additional band. As shown in Figure 5a, such a band may lie in another frequency band or, as shown in Figure 5b, may be arranged such that it is superimposed on the uplink and downlink frequencies.

Figure 6 shows a transmission/reception process within a transmission/reception cycle which is subdivided into eight timeslots (0 to 7). The semiduplex band (see Figure 6a) allows transmission and reception at the same frequency, with transmission and reception each being carried out in different timeslots. The reference symbol RXs in this case denotes reception, and TXs transmission of signals in the semiduplex band. The semiduplex band timeslots are synchronized to the duplex band timeslots (see Figure 6b) as in the GSM system, but they may differ both in the nature of the transmission and in length. The reference symbol RX denotes reception and TX denotes transmission of signals in the duplex band. Overall, this makes it is possible to work virtually simultaneously in both bands (see Figure 6c).

As shown in Figure 1, a mobile station A communicates with the base station using the duplex mode. In addition, the mobile station A can set up communication using the semiduplex mode with the mobile station B. There is no link between the mobile station B and the base station. It is, thus, possible for the mobile station A to communicate simultaneously with the base station and the mobile station B.

Figure 2 shows a situation in which the mobile station A is being used as a repeater. As in the situation shown in Figure 1, there is a direct link between the base station and the mobile station A, while there is no direct link between the base station and the mobile station B. However, the mobile station A converts the semiduplex mode information transmission to duplex mode information transmission, and vice versa, so that communication is set up between the base station and the mobile station B. As such, data is transmitted using the semiduplex mode from the mobile station B to the mobile station A, processed in the mobile station A and passed on using the duplex mode to the base station. In the opposite direction, the data is transmitted from the base station to the mobile station A using the duplex mode, processed in the mobile station A, and passed on to the mobile station B using the semiduplex mode.

As shown in Figure 3, it is likewise possible forthe mobile station A to communicate simultaneously with the mobile station B and the mobile station C using the semiduplex mode or, as a repeater, to receive information in the semiduplex mode from the mobile station B, and to pass it on to the other mobile station C using the semiduplex mode (or vice versa). Direct coupling between the mobile stations B and C would be impossible since the mobile station B is located in an area (valley) which is shadowed from the mobile station C.

It is also possible to form a chain which includes a greater number of mobile stations.

The mobile stations have a control device which chooses between operation with one or two further stations or else operation as a repeater. If required, the control device may automatically select operation as a repeater. However, in order to avoid loading the power supply device in a mobile station in an uncontrolled manner, operation as a repeater can be inhibited.

The advantage of the mobile radio system in the present invention, in which mobile stations can be operated as repeaters, is, as described above, that even mobile stations which have no direct link to a base station due to shadowing can set up communication to other mobile stations and to the base station. A further advantage is that a mobile station likewise can be operated from an aircraft.In a conventional mobile radio system, operation of a mobile station from an aircraftwhile flying is normally impossible since the mobile station cannot set up communication with a specific base station from the large number of accessible base stations. By using mobile stations as repeaters which operate at a frequency suitable for them, however, it is possible to set up communication with one base station.